

[0017] Texturizing or texturing describes a process where an electronic device using controlled ultrasound over air may provide, simulate, or mimic friction, pulsing sensation, pulsating sensation, variable smoothness, variable thickness, coarseness, fineness, irregularity, a movement sensation, bumpiness, or rigidity that is sensed by or detectable by an object.

[0018] U.S. application Ser. No. 12/406,273 is herein incorporated by reference as if fully set forth and may be used in combination with the given examples to provide a display device that is elevated, indented, or texturized and ultrasound is used to provide a sensation to an object near the display device.

[0019] FIG. 1 is a diagram of a wireless subscriber unit, user equipment (UE), mobile station, pager, cellular telephone, personal digital assistant (PDA), computing device, surface computer, tablet computer, monitor, general display, versatile device, automobile computer system, vehicle computer system, or television device **100** for mobile or fixed applications. Device **100** comprises computer bus **140** that couples one or more processors **102**, one or more interface controllers **104**, memory **106** having software **108**, storage device **110**, power source **112**, and/or one or more displays controller **120**. In addition, device **100** comprises an elevation, indenting, or texturizing controller **121** to provide sensations an object located near one or more display devices **122**.

[0020] One or more display devices **122** can be configured as a liquid crystal display (LCD), light emitting diode (LED), field emission display (FED), organic light emitting diode (OLED), or flexible OLED display device. The one or more display devices **122** may be configured, manufactured, produced, or assembled based on the descriptions provided in US Patent Publication Nos. 2007-247422, 2007-139391, 2007-085838, or 2006-096392 or U.S. Pat. No. 7,050,835 or WO Publication 2007-012899 all herein incorporated by reference as if fully set forth. In the case of a flexible display device, the one or more electronic display devices **122** may be configured and assembled using organic light emitting diodes (OLED), liquid crystal displays using flexible substrate technology, flexible transistors, or field emission displays (FED) using flexible substrate technology, as desired. One or more display devices **122** can be configured as a touch screen display using resistive, capacitive, surface-acoustic wave (SAW) capacitive, infrared, strain gauge, optical imaging, dispersive signal technology, acoustic pulse recognition, frustrated total internal reflection or magneto-strictive technology, as understood by one of ordinary skill in the art.

[0021] Coupled to one or more display devices **122** may be pressure sensors **123**. Coupled to computer bus **140** are one or more input/output (I/O) controller **116**, I/O devices **118**, GPS device **114**, one or more network adapters **128**, and/or one or more antennas **130**. Device **100** may have one or more motion, proximity, light, optical, chemical, environmental, moisture, acoustic, heat, temperature, radio frequency identification (RFID), biometric, face recognition, image, photo, or voice recognition sensors **126** and touch detectors **124** for detecting any touch inputs, including multi-touch inputs, for one or more display devices **122**. One or more interface controllers **104** may communicate with touch detectors **124** and I/O controller **116** for determining user inputs to device **100**.

[0022] Ultrasound source/detector **125** may be configured in combination with touch detectors **124**, elevation, indent-

ing, or texturizing controller **121**, one or more display devices **122**, pressure sensors **123**, or sensors **126** to project or generate ultrasound waves, rays, or beams to an object to simulate elevated, indented, or texturized sensations, recognize inputs, or track the object as will be explained in more detail below. There may be cases for input recognition or object tracking wherein an ultrasound is provided without detected sensation to the object.

[0023] Still referring to device **100**, storage device **110** may be any disk based or solid state memory device for storing data. Power source **112** may be a plug-in, battery, solar panels for receiving and storing solar energy, or a device for receiving and storing wireless power as described in U.S. Pat. No. 7,027,311 herein incorporated by reference as if fully set forth. One or more network adapters **128** may be configured as a Time Division Multiple Access (TDMA), Code Division Multiple Access (CDMA), Orthogonal Frequency-Division Multiplexing (OFDM), Orthogonal Frequency-Division Multiple Access (OFDMA), Global System for Mobile (GSM) communications, Enhanced Data rates for GSM Evolution (EDGE), General Packet Radio Service (GPRS), cdma2000, wideband CDMA (W-CDMA), long term evolution (LTE), 802.11x, Wi-Max, mobile Wi-MAX, Bluetooth, or any other wireless or wired transceiver for modulating and demodulating information communicated via one or more antennas **130**. Additionally, any of devices, controllers, displays, components, etc. in device **100** may be combined, made integral, or separated as desired. For instance, elevation, indenting, or texturizing controller **121** may be combined with ultrasound source/detector **125** in one unit.

[0024] FIGS. 2a-2d are diagrams of configurations for providing elevated, indented, or texturized sensations to an object using ultrasound. In FIG. 2a display device layer **204** lays proximate to ultrasound layer **205**. Although a single layer is shown, layers **204** and **205** can be composed of a plurality of sublayers. Although display device layer **204** is shown above that ultrasound layer **205**, some or most of the components of ultrasound layer **205**, such as ultrasound transducer or detectors, may be provided in substantially the same level plane as display device layer **204**. Display device layer **204** can be either a flexible or rigid display device for displaying video, images, photos, graphics, text, etc.

[0025] Ultrasound layer **205** can be configured and composed of ultrasound transducer, source, or detector devices as described in "Two-dimensional scanning tactile display using ultrasound radiation pressure" by Shinoda et al. (2006), "A Tactile Display using Ultrasound Linear Phased Array" by Shinoda et al. (2004), or "Small and Lightweight Tactile Display (SaLT) and Its Application" by Kim et al. (2009) that are all herein incorporated by reference as if fully set forth. As indicated by the incorporated references, linear phased arrays of ultrasound can provide at least 1 mm diameter focal or control points for fine, precise tactile airborne stimuli at variable frequencies and intensities. Larger focal points may also be provided. Techniques for tracking or detecting motion of a focal or control point and object may include Time Delay of Arrival (TDOA) where the difference in arrival times and the velocity of an ultrasound at one or more detectors is used to establish and track location. Airborne refers to an ultrasound transmission that may propagate through the air for at least a predetermined distance.

[0026] As previously stated, stimuli can be provided to an object by transmitting one or more ultrasound focal points to cause a vibration, gyration, beat, or tap by a phased array. The